DEVELOPMENT OF TEST RIG FOR KNEE PAD

MOHD YUSRI BIN SHAMSUDDIN

Report submitted in partial fulfilment of the requirements
For the award of
Diploma in Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2012

ABSTRACT

This thesis presents the fabrication of automotive part using carbon fiber. In this modern era, carbon fiber became high demand in the market. This is because sports like racing such as sport car racing, motorcycle racing and bicycle racing become famous. So carbon fiber became popular among the racer because carbon fiber is strong, light at once can reduce the part of automotive and increase the speed of vehicle. Beside carbon fiber do not rust and the out layer is interesting. The project has to begin with choosing 4 automotive parts. The selected parts are side mirror, box, motor cycle body part and oil tank cover. These parts consist of different shape which is flat, curve and flat curve. Based on that, the difficulty of fabricate this project can be determined. These parts have designed using SolidWork engineering drawing software for the structural three-dimensional solid modeling. All the step and procedure of fabricate the glass fiber and carbon fiber was listed in this thesis. The problem faced during making this project and the problem solving also have in this thesis. Lastly, for making the product better and perfect the recommendation for the future work was been discussed in this thesis.

ABSTRAK

Tesis ini membentangkan tentang fabrikasi bahagian automotif menggunakan gentian karbon. Dalam era modernisasi ini, gentian karbon semakin mendapat permintaan yang tinggi di pasaran. Ini adalah kerana sukan perlumbaan seperti sukan lumba kereta, lumba motosikal dan lumba basikal menjadi semakin terkenal. Oleh sebab itu, serat karbon menjadi popular dalam kalangan pelumba kerana gentian karbon adalah kuat dan ringan,sekali gus boleh mengurangkan berat bahagian automotif dan meningkatkan kelajuan kenderaan. Selain itu, serat karbon tidak berkarat dan mempunyai lapisan luar yang menarik. Projek ini bermula dengan memilih 4 bahagian automotif. Bahagian-bahagian yang dipilih adalah cermin sisi, kotak, bahagian badan motorsikal dan penutup tangki minyak. Bahagian-bahagian ini terdiri daripada bentuk yang berbeza iaitu rata, lengkuk dan lengkuk rata. Oleh itu, tahap kesukaran menghasilkan projek ini dapat ditentukan dengan mengikut bentuk bahagian. Bahagian-bahagian ini telah direka menggunakan SolidWork kejuruteraan perisian lukisan untuk pemodelan struktur tiga dimensi . Semua langkah dan prosedur meghasilkan gentian kaca dan gentian karbon telah disenaraikan didalam tesis ini. Masalah yang dihadapi semasa menghasilkan projek ini dan cara penyelesaian masalah juga tersenarai didalam tesis ini. Akhir sekali, untuk menghasilkan produk yang lebih baik dan sempurna, cadangan untuk menghasilkan produk ini pada masa hadapan telah dibincangkan dalam tesis ini.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF SYMBOLS

μm	Micrometer
ml	Milliliters
Kg	Kilogram

LIST OF ABBREVIATIONS

K	Thousands individual filaments in a tow
GRP	Glass-reinforced plastic
GFRP	Glass-fiber reinforced plastic
CF	Carbon fiber
VOC's	Volatile Organic Compounds

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This project title is fabrication of automotive body part using carbon fiber. The material use in this project will reduce the mass of automotive part, increase the acceleration of vehicle and also can stand high impact. This carbon fiber part is produce by 2 layers if E-glass chopped strand using the polyester resin and one layer of 3K carbon fiber using the epoxy resin. The fabrication required student to familiar the procedure and safety on handling fiber glass and carbon fiber and other materials such as resin and other solvent.

1.2 PROBLEM STATEMENT

The common automotive parts in market or factory are typically made out of steel, but aluminium is rapidly gaining popularity with auto companies. Although these materials are tough enough to absorb the high energy from the crash but it's quite heavy to use. Using the fiberglass (glass-fiber reinforced plastic, or GFRP) and carbon fiber are not only increasing the acceleration and reduce the mass of automotive part but it will also provide versatility and freedom of design, strength & durability.

1.3 OBJECTIVE

There are three objectives of this project as follow:

i. To fabricate automotive component using carbon fiber.

ii. Reduce the mass of automotive component

iii. Increase the acceleration of vehicle

The function of this project objective is to determine whether the result of the product is fulfill the objective or not.

1.4 SCOPE

The scope of this project is:

i. Fabricate the carbon fiber part with good surface finish.

ii. Reduce the weight of the body part

iii. One layer of Carbon Fiber with two layer of fiberglass

The function of the scope is to control the fabrication of the product so that the work that performed is under the objective.

1.5 THESIS ORGANIZATION

Chapter review is to briefing the chapter shortly from chapter one until chapter five. This is to make sure that the chapter is under the title that given.

i. Chapter one

In chapter one, there is introduction. Which is include project synopsis, project scope and project objective. Based on this chapter, the title of the project can be determines.Besides that, the objective of this project was listed and to control the objective there is the project scope.

ii. Chapter two

Chapter two consists of literature review. At this chapter, the background of the part and materials that use can determine. Besides that, the type and advantages of the product that use also can be known. The method and type of joining also listed in this chapter.

iii. Chapter three

This chapter is methodology. This chapter consists of the flow chart of the project. How the project is worked and flow also can be known. What the method that use in this project can be determine. Besides that, there is the step or procedure of making the fiber glass and carbon fiber part.

iv. Chapter four

Chapter four is result and discussion. This chapter shows the image of the product that produce in this project. Besides that, there is the discussion which is consists of the problem facing while fabricate this product and the problem solved. In this chapter are more details about how the problem can occurs and how to solving it.

v. Chapter five

Chapter five is conclusion and recommendation which is included of conclusion of this project and the recommendation for future work. The conclusion of this project can be determine. Next, the recommendation of this product to make the product better and perfect have listed in this chapter

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, the importance and application of the composite materials at several sectors will be discussed. This chapter will inquired into the general properties of the components that commonly used to produce polymer composite materials which are fiber glass and carbon fiber. Next, the step and procedure of making a part (fiberglass) and carbon fiber will be covered. Through this chapter, the details of the composite materials can be understood in depth. The roles of build orientation in mechanical properties of the composite materials also can be studied deeply. Hence, the advantages and disadvantages of fiberglass and carbon fiber will be listed so we can choose the suitable materials properly.

2.2 AUTOMOTIVE PART

Automotive parts such as car's body is very important part which is it must strong, hard and rust resistance. Most auto bodies are made of sheet metal (steel) and aluminum in varying mixes, because steel is malleable, it is capable of being shaped into the forms needed to create the chassis and body panels of automobiles. Steel is able to be poured into molds and cooled to create other forms, such as an engine block. And steel is easy to bond together using welding techniques.

The price of steel is low relative to many other metals. Although aluminum and carbon fiber is lighter than steel and has a similar strength-to-weight ratio, it is significantly more expensive and so is only used in high-end automobiles. Steel is plentiful and cheap. But depends on the car, mostly carbon steel, its strong but formable, moderately rust resistant but usually coated with other metals (zinc or chrome) or other materials for rust resistance. Deloreans (brand of car, production officially began in 1981) are made with stainless steel. The metal was brushed instead of painted and stainless (most grades) is very rust resistant. Stainless is more expensive than carbon steel and since it was not painted repairs would be visible so it usually was replaced when damaged.

Sometimes aluminum is used when strength is not critical. Aluminium is rust proof, light weight, lower strength and more expensive than steel. It is also used in high end (lower production numbers) to improve power to weight ratios and to reduce tooling costs as it is easier to form than steel.

2.3 FIBERGLASS

2.3.1 Definition

Fiberglass (also called glass-reinforced plastic, GRP, glass-fiber reinforced plastic, or GFRP) is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. Common uses of fiberglass include high performance aircraft (gliders), boats, automobiles, hot tubs, water tanks, roofing, pipes, cladding, casts, surfboards and external door skins.

2.3.2 Characteristic

Fiberglass is a lightweight, extremely strong, and robust material. Although strength properties are somewhat lower than carbon fiber and it is less stiff, the material is typically far less brittle, and the raw materials are much less expensive. Its bulk strength and weight properties are also very favorable when compared to metals, and it can be easily formed using molding processes. Glass is the oldest, and most familiar, performance fiber. Fibers have been manufactured from glass since the 1930s.

2.3.3 Type

As to the raw material glass used to make glass fibers or nonwovens of glass fibers, the following classification is known:

i. A-glass: With regard to its composition, it is close to window glass. In the Federal Republic of Germany it is mainly used in the manufacture of process equipment.

ii. C-glass: This kind of glass shows better resistance to chemical impact. Mainly used in the form of surface tissue in the outer layer of laminates used in chemical and water pipes and tanks.

iii. E-glass: This kind of glass combines the characteristics of C-glass with very good insulation to electricity. Good tensile and compressive strength and stiffness, good electrical properties and relatively low cost, but impact resistance relatively poor. Widely used.

iv. AE-glass: Alkali resistant glass.

2.4 CARBON FIBER

2.4.1 Definition

Carbon fiber, alternatively graphite fiber, carbon graphite or CF, is a material consisting of fibers about 5–10 μm in diameter and composed mostly of carbon atoms. The carbon atoms are bonded together in crystals that are more or less aligned parallel to the long axis of the fiber. The crystal alignment gives the fiber high strength-to-volume ratio (making it strong for its size). Several thousand carbon fibers are bundled together to form a tow, which may be used by itself or woven into a fabric. Although carbon fiber can be relatively expensive, it has many applications in aerospace and automotive fields, such as Formula One. The compound is also used in sailboats, rowing shells,

modern bicycles, and motorcycles, where its high strength-to-weight ratio and very good rigidity is of importance.

2.4.2 Properties

The properties of carbon fibers, such as high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion, make them very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. Carbon fibers are usually combined with other materials to form a composite. When combined with a plastic resin and wound or molded it forms carbon fiber reinforced plastic (often referred to as carbon fiber) which has a very high strength-to-weight ratio, and is extremely rigid although somewhat brittle. However, carbon fibers are also composed with other materials, such as with graphite to form carbon-carbon composites, which have a very high heat tolerance.

2.4.3 Type

Fibers are bundled in various sizes designated in thousands (K) of fibers. 1K, 3K, 6K, 12K, 24K, 50K and others are common bundle sizes. These fibers are woven into fabric with various weave patterns. 3K fabric is most common. The various types of fiber will have the same “K” designation to indicate the number of fibers in the bundle. These numbers describe the size of the bundle used and have little to do with the quality of the fiber itself. The "K" stands for thousands so there are 3,000 individual filaments in a 3k tow, 6,000 strands in 6k, and so on.

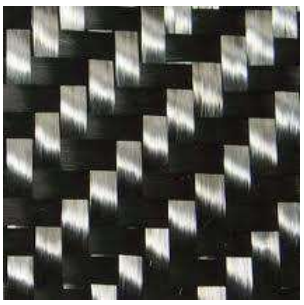

Figure 1.1: 3K

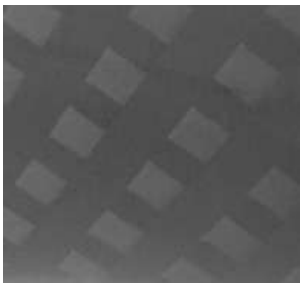

Figure 1.3: 12K

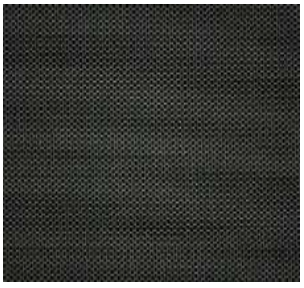

Figure 1.4: 1K

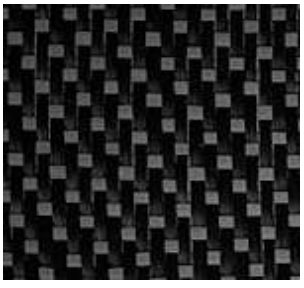

Figure 1.5: 6K

2.5 RESIN

2.5.1 Definition

Resin in the most specific use of the term is a hydrocarbon secretion of many plants, particularly coniferous trees. Resins are valued for their chemical properties and associated uses, such as the production of varnishes, adhesives and food glazing agents. They are also prized as an important source of raw materials for organic synthesis, and as constituents of incense and perfume.

2.5.2 Type and Properties

i) Epoxy resin

The large family of epoxy resins represent some of the highest performance resins of those available at this time. Epoxies generally out-perform most other resin types in terms of mechanical properties and resistance to environmental degradation, which leads to their almost exclusive use in aircraft components. As a laminating resin their increased adhesive properties and resistance to water degradation make these resins ideal for use in applications such as boat building. Here epoxies are widely used as a primary construction material for high-performance boats.

ii) Vinylester resins

Vinylester resins are stronger than polyester resins and cheaper than epoxy resins. Vinylester resins utilize a polyester resin type of cross-linking molecules in the bonding process. Vinylester is a hybrid form of polyester resin which has been

toughened with epoxy molecules within the main moleculer structure. Vinyester resins offer better resistance to moisture absorption than polyester resins but it's downside is in the use of liquid styrene to thin it out (not good to breath that stuff) and its sensitivity to atmospheric moisture and temperature. Sometimes it won't cure if the atmospheric conditions are not right. It also has difficulty in bonding dissimilar and already-cured materials. It is not unusual for repair patches on vinylester resin canoes to delaminate or peel off.

iii) Polyester resin

Is the cheapest resin available in the marine industry and offers the poorest adhesion, has the highest water absorption, highest shrinkage, and high VOC's. Polyester resin is only compatible with fiberglass fibers and is best suited to building things that are not weight sensitive. It is also not tough and fractures easily. Polyesters tend to end up with micro-cracks and are tough to re-bond and suffer from osmotic blistering when untreated by an epoxy resin barrier to water. This is really cheap and widely used stuff.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will discussed about methods and procedure taken order to fabricate of automotive body part using carbon fiber.

Before start on fabrication process,

1) Have automotive parts that want to be change to fiberglass part. Automotive parts are consists of 4 which is in different shape. First is box shape which is car accessory, second is curve shape which is side mirror of motorcycle. Third is flat shape which is oil cover car part. Last is curve shape which is body part of motorcycle.

2) Prepare the materials that needed. The materials are sellotape, resin, hardener, fiberglass, carbon fiber, brush, scissor, glove, cups, stick, abrasive paper, polish, wax polish, compound.

3) Fiberglass. The type of fiberglass is E-glass which is good tensile, compressive strength and stiffness. Good electrical properties, low cost and most common use. The resin that we used is polyester resin which is widely used and low cost.

4) Carbon fiber. The type of carbon fiber is 3k and the resin is epoxy resin which is highest performance resin at this time. Epoxies is generally greater capability, very reliable and strong.